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Metal modified paper-based microfluidic substrates for potentiometric determination of lead ions in complex environmental samples

Rochelle Silva ^{a,b*}, Ashiq Ahamed ^b, Yi Heng Cheong ^{b,c,d}, Ke Zhao ^{b,c}, Ruiyu Ding ^{b,c}, Grzegorz Lisak ^{b,c}

^a Interdisciplinary Graduate Programme, Nanyang Technological University, 61 Nanyang Drive, Academic Block North, Singapore 637335, Singapore

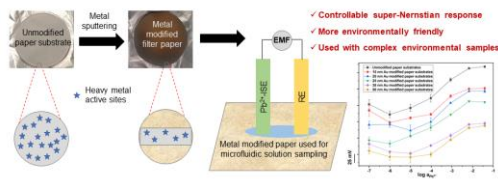
^b Nanyang Environment and Water Research Institute, Residues and Resource Reclamation Center, 1 Cleantech Loop, Cleantech, Singapore, 637141, Singapore

^c College of Engineering, School of Civil and Environmental Engineering, Nanyang Technological University, 50 Nanyang Avenue, Singapore, 639798, Singapore

^d Robert Bosch (South East Asia) Pte Ltd, 11 Bishan Street 21, 573943, Singapore

* Corresponding author Email: silv0008@e.ntu.edu.sg

Potentiometric determination of lead ions using Pb²⁺-ion selective electrodes (ISEs) is hindered when coupled with unmodified microfluidic sampling paper-based substrates. In such instance, the super-Nernstian response of the electrode is believed to be caused by interactions between lead ions and functional groups on paper-based substrates. In this work, various metal modified instead of unmodified paper-based substrates were used in controlling properties of the paper substrates in relation to their interactions with primary ion. Different thicknesses of gold, platinum and palladium were sputtered onto paper substrates, followed by their use in potentiometric measurements with Pb²⁺-ISEs. The results revealed that the thickness of the metal layers on paper substrates influenced the potentiometric response of the electrode. Out of all samples investigated, paper-based substrates coated on both sides with 38 nm gold layers were found the most suitable in controlling the super-Nernstian response of ISEs [1]. Additionally, a durability study was conducted where the lifetime of Pb²⁺-ISEs was investigated when used with modified paper-based substrates and when used directly on complex environmental samples with high solid-to-liquid content. It was found that for complex environmental samples the use of modified paper-based substrates almost doubles the lifetime of the electrode. The data was also used to conduct a detailed life cycle assessment for model screen printed potentiometric sensors with and without metal modified paper-based solution sampling substrates and results indicated that the environmental impact per potentiometric measurement of Pb²⁺-ISE was lower in sensors utilizing metal modified paper-based solution sampling substrates.



Schematic for the use of metal modified paper-based substrates coupled with Pb²⁺-ISE

- [1] R. Silva, A. Ahamed, Y.H. Cheong, K. Zhao, R. Ding, G. Lisak, Non-equilibrium potentiometric sensors integrated with metal modified paper-based microfluidic solution sampling substrates for determination of heavy metals in complex environmental samples, *Anal. Chim. Acta.* 1197 (2022) 339495. <https://doi.org/10.1016/j.aca.2022.339495>.